II.

IN SURGICAL DIAGNOSIS.

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The surgical cases that were examined by this method consisted of:

1. A burned hand (Plate I.) with anchylosis of all the fingers at the knuckle-joints and some necrosis of the metacarpal bones, which were in great part soldered together, the little finger being curved under the ring-finger. The skiagraph shows well the bones in the fingers. In the metacarpus, the reason for the fusing of nearly all the picture is that the bones, as a consequence of the very severe burn between the rollers of a heated mangle, were completely soldered together in one mass. It will be noticed that the little finger, even where it passes under the ring-finger, is well seen. Fig. 1 is an ordinary photograph of the same hand.

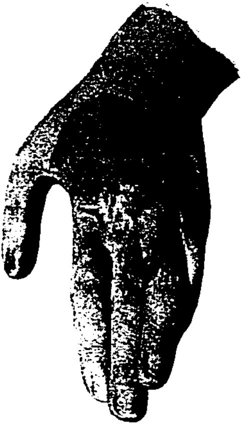
2. A tubercular elbow-joint (Plate II.) in a child of twelve years, in which it will be observed that not only the humerus shows, but also the radius and ulna. (Compare this with Plate III. of a stouter arm.)

3. The elbow-joint (Plate III.) of a young man of twenty years, who, twelve years ago fell, striking his olecranon violently on a bit of railroad iron, driving the ulna into the groove between the two condyles of the humerus and wedging them apart. The condyles, especially the inner, show well; the radius and ulna were in such contact as to appear only as one. Fig. 2 shows an ordinary photograph of the same elbow, though it by no means presents the extreme deformity as one sees it from various points of view. Strange to say, flexion and extension were excellent.

4. An elbow (Plate IV.) which had been resected for tubercular disease a few days before. This was in plaster-of-Paris splints encasing respectively the arm and the forearm, with a bar of iron extending between the two in order to fix the elbow rigidly. The skiagraph shows the plaster-of-Paris splint and the iron cross-bar. It is to be observed that the plaster is opaque to the rays, while on the contrary the gauze-dressing and the bandages which thickly encased the elbow and the bar were translucent to them. The ends of the resected bones of the forearm show only very faintly, and the end of the humerus also, probably (as the bar shows) from the movements of the child or some modification of the rays by the dressing and bandages.

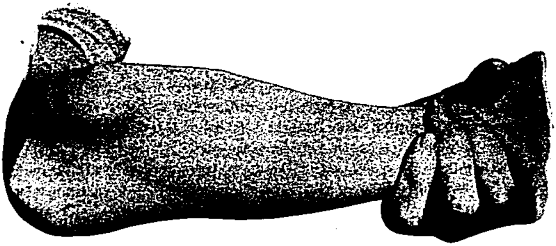
5. A shoulder-joint with a recent resection of about three inches of the humerus, on account of an old dislocation with fracture of the surgical neck followed by a late osteomyelitis. This picture was also

Fig. 1.



Photograph of burned hand.

Fig. 2.



Photograph of fractured elbow.

taken without removing the bandage and dressing, by fastening the sensitized plate in its holder immediately behind the shoulder, while the Crookes' tube was placed in front of the shoulder, the patient lying sidewise in a bed. The skiagraph shows the outline of the edge of the scapula only; presumably the parts were too thick. Another difficulty was the constant respiratory movement, which has aided in blurring the outlines.

6. I attempted to skiagraph the trephine-opening in a case operated on four years ago, but, though the sensitized plate was left exposed for somewhat over an hour, no picture whatever appeared upon it. Whether this was due to a defect in the plate or in the tubes, or whether, as it seems to me more likely, to the impossibility at present to skiagraph through even one thickness of the skull, I do not know. The patient lay upon a bed with her head resting on a sensitized plate, the trephine-opening being next the plate and the Crookes' tube on the opposite side of the head. The head was not shaven.

7. Plate V. shows a hand of an uninjected cadaver. In it will be observed not only the bones and their cartilaginous extremities, but also in the thumb the sesamoid bones. A needle was thrust into the thumb up to its eye. This foreign and more opaque body comes out much more sharply than do the bones. Under the metacarpal bones of the fore and middle fingers are seen two large buckshot. These were inserted on the palmar surface of the hand, and are, therefore, seen through the bones. The skiagraph shows an enlargement of the head of the metacarpal bone of the thumb, which was found, by subsequent dissection, to be the result of an old injury. Plate VI. shows the wrist of the same hand, the carpal bones and the radius being fairly distinct. The metacarpals and the needle are much less distinct than in Plate V., and the buckshot show blurring at the edges. This is probably due partly to an accidental displacement of the hand, and the indistinctness of the metacarpals to their greater distance from the plate in Plate VI. than in Plate V.

We were anxious, also, at the ingenious suggestion of Mr. Arthur H. Lea, to see whether the hand of a dead person would act differently from the hand of a living person in intercepting the passage of the Röntgen rays, in order that it might be used as a test of death, but, so far as we can judge, no such difference appears.

8. The following specimens of bacteria were exposed to the rays in order to test their effect on the bacteria, namely: pink streptococcus, anthrax, micrococcus prodigiosus, micrococcus cereus flavus, sarcina aurantiaca, yellow sarcine, tubercle-bacillus, for first thirty minutes and then twice for fifteen minutes. In order to prevent the unfavorable effect of the glass tubes, they were so placed that the rays reached the bacteria through the cotton stopper. The tube of tubercle-bacilli was exposed

sidewise through the glass, and not lengthwise through the cotton, for one hour. Dr. Kyle reported that inoculations showed a good, strong growth from all of them. No lethal or even inhibitory effect was therefore seemingly produced upon these bacteria by an hour's exposure to the rays.

CLINICAL CONCLUSIONS. The above facts, together with other reports in various medical and lay journals, show clearly that the thinner portions of the body can be skiagraphed with considerable accuracy. This is true of parts of the body as thick as an ordinary elbow. Whether it will be true of the thicker parts of the body, *e. g.*, shoulder and trunk, is doubtful with present methods.

The effect of doubling the thickness through which the rays pass is admirably shown in the skiagraph of a foot in the *British Medical Journal*, February 8, 1896. Where two toes overlapped the skiagraph is twice as dark as where it was taken through a single toe.

One of the difficulties we have had has been the length of time necessary to take the pictures. The shortest exposure in any of these has been twenty minutes with extra quick plates made specially for us by Mr. Carbutt. We observe in the newspapers that it has been stated that instantaneous pictures have been lately taken by Edison and others. If this be so, it will aid materially in getting better-defined pictures both by relieving the patient of the irksomeness and even impossibility of remaining absolutely still for so long a time, as in the old daguerrotype, and by obviating the blurring consequent upon respiratory movements of the chest and the abdomen. The skiagraph of five years hence will be as superior to such as we present herewith as our present photographs are superior to those of forty years ago.

To sum up the clinical results obtained by ourselves and others, it is evident that of the *normal structures of the body* it would seem that all are permeable to the rays except the bones, and, therefore, it is not very probable, at least with our present methods, that we can determine much about them, although in the *British Medical Journal*, February 8, 1896, Mr. Sidney Rowland states that Adolph and Lenz, of Elberfeld, have been able to get pictures of *connective tissue.*

The *bones* are opaque to the rays, hence deformities, injuries, and diseases of bone will be more or less amenable to diagnosis by this method. The best illustration of this that we have seen is the case reported and figured in the *British Medical Journal*, already alluded to. In this case the distal phalanx of the great toe appeared to be double, as though there were two bones in the last joint. There was difficulty in distinguishing which of the two bones was the normal phalanx and which the supernumerary. Prof. Mosetig, therefore, took a skiagraph and was able instantly to determine which was the normal and which the abnormal phalanx.

We shall probably be able to differentiate *fracture* and *dislocation* even possibly in the thicker parts of the body when our methods have become more perfect. As has been pointed out in *The Medical News* of February 22, 1896, this may be of much use in obscure cases with great swelling, for the swelling is not impermeable to the rays. Suspected greenstick fractures can be made evident, and in any case in which possibly a claim for malpractice would be made, if, after the bones are adjusted, they were skiagraphed through the dressings, including even the ordinary board splints (plaster, of course, would not do), such a skiagraph might be of great value in court. Even if not needed for such medico-legal purposes, it would be of value to the surgeon in assuring him that everything is in proper order. *Exostoses and bony tumors* of any kind can thus undoubtedly be diagnosticated. *Cartilage* is translucent to the rays.

Gall-stones have been skiagraphed outside of the body (but not yet in the living body) by Neusser, Goodspeed, and Cattell (*The Medical News*, February 15, 1896, p. 169), but although only obscured by the thickness of the wall of the bowel into which the gall-stone had been thrust, no diagnosis could have been made from it. If we did not know a gall-stone was there, we could not have guessed it.

Phosphatic and probably other *urinary calculi* Neusser has shown to be quite impenetrable to Röntgen rays (as would be suspected by the impermeability of plaster-of-Paris in Plate IV.), but it is very doubtful whether we will be able to utilize them in diagnosis, on account of the bladder lying in the pelvic basin, the bones of which would cut off the rays. The kidneys at present cannot be skiagraphed, as the rays will not pass through so thick a part of the body. *Renal calculi* are as yet beyond our diagnosis by this method.

It is very doubtful also whether our diagnosis of *tumors* will be much aided by this new method, excepting in cases of bony tumors. Other tumors seem to be as translucent to the rays as the soft parts of the body. In tumors of the brain, the bones of the head (especially as the rays would have to penetrate *two* thicknesses of bone) will absolutely preclude any use of this method in diagnosis.

All such statements as the above apply, of course, only to our present knowledge. It is not only possible, but very probable, that we shall be able to accomplish very much more by the improvements which will be introduced into the method within the next few years.

Probably the most important use of the method will be in the location of *foreign bodies.* While some metals are translucent to the rays, others, and fortunately the common foreign bodies, are not translucent: thus in Plate V., of a dead hand, a *needle* thrust into the soft parts of the thumb shows with such striking clearness that we may positively say that, if a needle is suspected to exist in *any* part of the hand (and very often the history is obscure, so that we are doubtful whether the needle is really in the hand or not), by means of the Röntgen rays we can positively determine its existence and location.

The same skiagraph shows two *buckshot* which were placed purposely in the palm of the dead hand, and they are clearly seen even through the metacarpal bones. This method has actually been utilized already in several instances, according to the daily papers. Once by von Bergmann, in Berlin, Bury, of Chicago, and several others who have been able to find bullets and shot believed to be imbedded for a long while in the body. It is almost needless to add, as von Bergmann has pointed out, that most of such missiles, if they are quiescent, would be best utilized as phenomena than removed.

Fortunately, also, *glass* is very opaque to the rays, and if the hand is cut by glass, the existence of any pieces which might otherwise be overlooked can be disclosed by the Röntgen rays. One peculiar advantage of the method also is this: A hand supposed still to have a fragment of glass in it can be skiagraphed without removing the dressings even though they be moderately thick, as both gauze and bandages are permeable to the Röntgen rays. Thus Plate IV., of an elbow, was taken while covered with the ordinary voluminous surgical dressings.

The hand from which Plate VII. was taken is that of a patient, a young colored woman, who had suffered amputation of the third finger some months previously. There remains a very sensitive condition of the stump, and at one point a small area exquisitely painful to pressure. The skiagraph was undertaken to determine the condition of the end of the bone, to ascertain whether an enlarged nerve-end would give a shadow to the rays, and to secure any information leading to a choice of operative procedures for relief. The patient was brought for examination by Dr. Stricker Coles, to whom she had come for treatment. An examination of the end of the finger will show upon its ulnar aspect a slight enlargement of the tissues next the bone. No distinct enlargement of the nerve is visible by this method of inspection. This skiagraph was taken with an exposure of one hour without the use of the lead diaphragm and with the Crookes' tube a distance about fifteen inches from the hand. The plate is interesting for its clear delineation of the wrist. In view of the fact that no one point at the end of the stump could be demonstrated to be in a pathological condition capable of cure by operation, the patient was advised to submit to amputation of the metacarpal bone.